Microrheology of F-actin inferred from thermal motion of embedded particles: the importance of particle surface chemistry.

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In laser tracking microrheology (LTM) the viscoelastic properties of a polymer are inferred from the thermal motions of embedded particles. The approach provides revolutionary advantages over traditional mechanical rheometry including greater bandwidth, smaller test material requirements, and the capacity for highly localized measurements within cells. Despite disparity between LTM and traditional F-actin rheology, and critical theoretical assumptions about the interaction of particles with the test material, the importance of probe surface chemistry has not been evaluated. Exploring a number of particle chemistries, we find a correlation between the capacity of a particle to bind F-actin and the low frequency modulus it senses. Over a two order-of-magnitude range of gel stiffnesses, particles with no capacity to bind F-actin reveal weak moduli compared to mechanical rheometry. Surface chemistries which directly bind filaments produce good agreement with mechanical rheometry in these same gels. High resolution electron micrographs insure that none of these surface chemistries induce important changes in the local density of filaments. We conclude that filament binding by probe particles is essential for accurate inference of
bulk, low frequency, F-actin mechanics using LTM. These results have implications for cellular applications of LTM and can resolve existing disparities between traditional rheometry and microrheology measurements on F-actin.

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